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SHORT REPORT

Communally breeding female Barn Owls are not related and do not invest similarly in the communal family

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Running head: Barn Owl Communal Nest

Capsule We report detailed information about relatedness and parental investment in a communal nest in the Barn Owl. Two unrelated females laid their eggs in a single nest cup and successfully raised four nestlings out of 11 laid eggs. Apparently, the yearling female was not incubating the eggs and was only occasionally hunting for the brood in contrast to the older female who invested more effort in parental care.

Communal breeding defines the situation where several females lay their eggs or give birth to their offspring in a single nest cup and cooperate to raise their offspring. While this breeding system occurs in mammals on a regular basis, particularly in rodents (Hayes 2000), it is much rarer in birds (see references in Hadad *et al.* 2015, plus Vehrencamp 1977, Vehrencamp & Quinn 2004, Riehl & Jara 2009). Because breeding communally can lead to intense conflict over how much each parent should invest in raising the family, communally breeding females are predicted to be related. A high degree of relatedness can ensure that the mothers are cooperative reducing the inclination to exploit each other (Rusu & Krackow 2004, Ferrari *et al*. 2015). Communal breeding can sometimes occur when breeding sites are rare or when the availability of mates is limited (Macedo & Bianchi 1997).

In Israel, two Barn Owl (*Tyto alba*) females recently bred in the same nest with a single male, each female incubating her own clutch side by side (Hadad *et al.* 2015). Twenty eggs were laid of which 19 hatched and 16 nestlings fledged. Unfortunately, it was not possible to investigate whether all eggs were sired by the same male, neither whether the two females were genetically related nor the degree to which they invested in maternal care. In the present note, we describe a new case of communal breeding in the Barn Owl discovered in Western Switzerland as part of a long-term population monitoring project. This is the first time that such a communal nest is recorded out of 2 093 broods monitored from 1986 to 2019 in this area. We performed paternity and maternity analyses, installed a camera trap to monitor parental activity at the nest and equipped the adults with GPS tags to determine their home range. This gave us the opportunity to gather detailed data on parental investment in a such rare breeding situation.

In 2017, a particularly successful season for Barn Owls, a single male bred with two females in the same nest-box (measuring 60 x 60 x 45 cm) located in the village of Salavaux (Fig. 1A). One of the two females was ringed M038044 as a breeding adult in 2016 in the same site and the other female was ringed M031531 as nestling in 2016 in Corcelles-près-Payerne, at 10.3 km from Salavaux. As we captured the parents of M031531 and ring all Barn Owls in a 1 000 km^2 study area since 1986, the parents of M031531 and M038044 could not be the same. Hence, the two females were not genetically related. We captured one male ringed M026276 as nestling in 2011 in Avenches at 2.8 km from Salavaux. Again, we know the identity of his parents demonstrating that this male was not related to any of his two partners. Before breeding communally in 2017, this male bred in Salavaux in 2012 (one brood), in 2015 (two broods) and in 2016 (one brood) in the same nest-box and in another one located at 540 m.

In total, the two females laid 11 eggs that were all fertilized and placed altogether as if they belonged to a single clutch. Although we do not have direct observations that the two females were incubating the eggs, it seems that mainly the oldest female M038044 was incubating the clutch because this individual had a well-developed brood patch in contrast to the youngest female M031531 whose brood patch contained less fat. This interpretation is consistent with the observation that when we visited the nest-box during the incubation period, the yearling female M031531 tried to escape by flying out of the nest-box and was captured in a net placed in front of it. In contrast, when we opened the nest-box the oldest female M038044 was still incubating the eggs and we could capture her by hand. This suggests that the oldest female was more involved in incubation duties than the other female. Of the 11 laid eggs, 10 hatched and two of the nestlings died before the ringing visit. Of the remaining 8 nestlings, the second oldest nestling fell off the nest (Fig. 1C), and the three youngest died before fledging. In a species with asynchronous hatching, this suggests that food supply was not sufficient to feed all chicks resulting in the death of the youngest individuals. Compared with the previous record of communal breeding in Israel (Hadad *et al*. 2015), this case had a considerably lower reproductive success (4 nestlings fledged out of 10 hatchlings compared to 16 fledglings out of 19 hatchlings in Israel) suggesting the parents adopted different strategies to rear their broods.

To assess the genetic contribution of each adult to the clutch, we collected a blood sample from all nestlings and the three parents. Genomic DNA of each individual was extracted using the DNeasy Blood & Tissue Kit (Qiagen, Hilde, Germany). Maternity and paternity were assessed with 10 microsatellite markers (multiplexes 3 and 4 described in Burri *et al.* 2016) following the method in Henry *et al.* (2013). These molecular analyses confirmed that at least 5 eggs were laid by M038044 and 3 eggs by M031531. For the remaining 3 eggs the identity of the mother was unknown as 1 egg did not hatch and 2 hatchlings died before we had time to collect a blood sample to perform maternity analyses. The mother of the oldest nestling, second oldest nestling, third, fourth and eighth oldest nestlings was M038044 and the mother of the fifth, sixth and seventh oldest nestlings was M031531. It implies that the oldest female laid a few eggs (starting on the 24^{th} of March) before the yearling female started to lay her own eggs. The lower number of eggs produced and the later laying of the yearling female could explain in part her lower investment in maternal care. These 8 nestlings were all sired by the same father M026276.

The oldest female M038044 was slightly bigger than the youngest M031531 (wing length 305 mm vs. 298 mm) and heavier (during incubation: 379 g vs. 360 g; during nestling rearing: 333 g vs. 321 g). Her age, higher body condition and higher offspring production may have predisposed her to invest more effort in maternal care than the yearling female. To examine this prediction, we recorded feeding events and other parental behaviors by placing a camera trap (HC500, HyperFire, Reconyx) in front of the nest entrance. Of a total of 9 nights of monitoring we removed the first and the last nights from the analyses as the bird capture might have altered their behavior. Over the course of seven nights, the male brought to his nestlings on average 6.71 prey items per night (in total 47, a maximum of 10 prey in a single night), whereas the old female M038044 provided 3.14 prey per night (in total 22, max 6) and the female M031531 0.71 items (in total 5, max 2). Interestingly, we observed that sometimes the male would give a prey item to the younger female M031531 waiting on the perch to distribute it to the nestlings (Fig. 1B). In addition, pictures taken by the camera trap revealed two peculiar events. On May 29th the second oldest nestling fell out of the nest-box (Fig. 1C) and on June 1st the female M031531 was seen going out of the nest with a dead nestling (Fig. 1D). We do not know if the nestling was already dead or whether the female killed it.

On May 25th when the nestlings were ringed, the adults were captured and equipped with GPS tags (GiPSy-5, Technosmart, Italy) to monitor their movements over a period of 9 nights. The tags weighed 12 grams and were attached as backpacks to the birds with a Teflon harness. They were set to record a geographic location every 10 sec, from 30 min before dusk to 30 min after dawn ensuring a complete recording of the owl's nocturnal activity. Ten days later, the tags of the male and one female (M038044) were recovered, while the second female M031531 could not be recaptured even though she was still feeding the brood occasionally (Fig. 2). We calculated home range size as 95% auto-correlated kernel density estimator using the continuous-time movement modelling package (ctmm; Fleming & Calabrese 2018) as implemented in the R software (R Core Team 2018). The ctmm models were calibrated using

UERE, estimated with stationary location data obtained in open landscape, and model parameters with better fit were chosen automatically with the function variogram.fit (Fleming & Calabrese 2018). We compared the home range size of the two communally breeding Barn Owls with the home range size of breeding owls at 18 other nests from the same study area and period of time (GPS installation date ranging from 15 May to 15 June). The home range size of the male M026276 was similar to the home range size of the 18 monogamous males (3.94 km^2 vs. mean ± SD: 5.52 ± 3.43 km^2) and the home range size of female M038044 was similar to the home range size of the 18 monogamous females (6.59 km^2 vs. 8.33 ± 6.04 km^2). Similarly, the mean distance covered per night by flying was similar in male M026276 as in the 18 monogamous males (22.46 km vs. 25.25 ± 6.94 km) and in female M038044 as in the 18 monogamous females (13.37 km vs. 18.72 ± 6.31 km).

Finally, we extracted information from the GPS data about the roosting locations during the daylight hours. The male and females did not roost together. It happened that both females spent the day together in the nest-box 3 times, whereas the male was never observed roosting inside his nest cavity. Over the 9 days with a GPS, he roosted in two different barns, 6 times at 540 m from his nest and three times at 990 m. The old female roosted in three different places, six times inside its nest, twice in a barn at 1.3 km from her nest and once in a forest on June 1st.

In this report, we present the first record of communal nesting in the Barn Owl in an extensively studied population in Western Switzerland. Two unrelated females bred with the same male, producing an uncharacteristically large clutch of 11 eggs (in our population mean ± SE is 6.04±0.05, in Chausson *et al.* 2014). Using GPS tags and camera trap pictures, we show that the male and the oldest female M038044 foraged for the brood more intensively than the youngest female (Fig. 2). However, both their home ranges and distance covered were similar to monogamous parents, suggesting that they did not increase their foraging activity to compensate for the poor investment of the youngest female, which may have contributed to the rather low reproductive success as only 4 nestlings fledged. The two females shared maternity suggesting that the youngest female exploited the oldest one to raise her own offspring.

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Figure 1. Camera trap pictures of the communal nest of Barn Owls in Western Switzerland. A) The three adults perched in front of the nest-box (hole in the wall on the right hand-side). From left to right: male M026276, younger female M031531 and older female M038044 (we could identify the females thanks to their very different plumage colouration and size). B) The male brings a prey item to the younger female M031531 waiting on the perch (the female then enters the cavity to deliver the prey to the chicks, while the male goes away). C) Barn Owl chick M037793 falling out of the nest-box (it then died). D) female M031531 taking a dead nestling out of the nest-box.

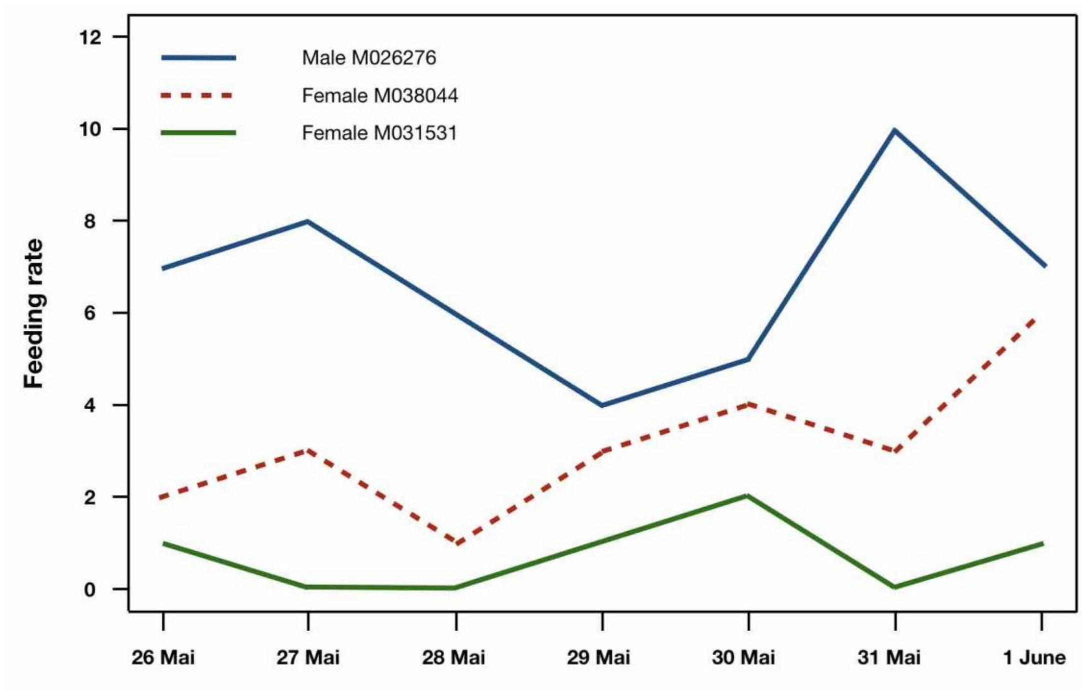

Figure 2. Number of prey items brought to the nest per night of the trio (one male and two females) at the Barn Owl communal nest.